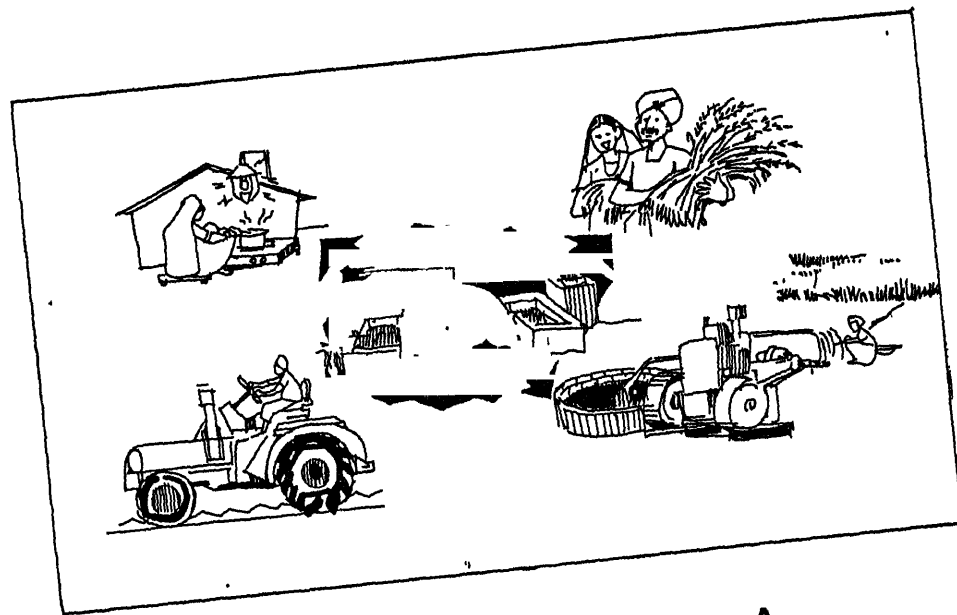
SPHERICAL BIOGAS PLANTS

A
Manual for Plant Owners

TATA ENERGY RESEARCH INSTITUTE
DOCUMENTATION AND INFORMATION CENTRE
7, JorBagh, New Delhi - 110 003

1988

This manual is compiled by Documentation and Information Centre, Tata Energy Research Institute, 7 Jor Bagh, New Delhi. 1988.

SPHERICAL BIOGAS PLANTS

A Manual for Plant Owners

TATA ENERGY RESEARCH INSTITUTE
DOCUMENTATION AND INFORMATION CENTRE
7, JorBagh, New Delhi - 110 003
1988

CONTENTS

FOREWORD

This manual dealing with Spherical Biogas Plants has been written in simple and easily understood language. Given the importance of biogas technology in the developing countries, the dissemination of knowledge for establishing biogas plants and the benefits that can be derived from them assumes importance. The experience of India in this field is particularly relevant to the spread of knowhow on biogas plants in other countries of the world.

The manual itself describes the basic principles of biogas plants, a discussion of benefits from their use and some institutional issues based on the Indian experience which would be of interest to potential biogas plant owners. Details for construction, operation and the use of biogas and fertilizer which are produced by the plant are then provided in a lucid and simple manner.

We would like to acknowledge the financial support and assistance of UNESCO in the execution of this project and enquiries on the subject would be most welcome and gladly answered by the staff of the Tata Energy Research Institute (TERI).

Dr. R.K. Pachauri
Director, TERI

WHAT IS BIOGAS?

Biogas is used as fuel for cooking. It can also be used for lighting lamps instead of kerosene or electricity. It can be produced from any type of organic waste. For example, it is produced from cattle dung, poultry waste, piggery waste etc.

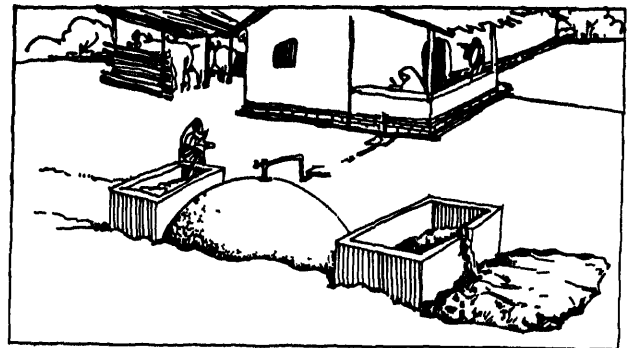
To get biogas you have to collect the cow dung available in your compound. Then you mix it with water. Thus you make a uniform solution. This solution is poured into an air-tight tank. There it gets digested by some bacteria. After a few days gas starts coming out from the tank. This is biogas; it is then taken to the kitchen to cook your food.

After all the gas is produced, the dung solution is still left out in the tank. This solution is a very good fertilizer - Just as dung is a good fertilizer. You can take it to the field and apply it to the crops.

Thus, biogas technology gives you both cooking fuel and fertilizer - at the same time, from the same quantity of dung.

Now do you want to know more about this new technology? Do you want to be the proud owner of a biogas plant? Come, let us have a look at this technology; let us see how it will benefit us; how it is going to bring prosperity and increased hygiene to our homes.

WHAT IS A BIOGAS PLANT?

Biogas plant is the air-tight tank in which biogas is produced. Your biogas plant is a big **Spherical tank.** It is air-tight. It almost has the shape of a football. The tank is built underground. So, what you can see from the outside is only the top portion of the spherical ball. On one side of the ball, there is a small tank. This tank is called the **Inlet tank.** It is connected with the spherical ball by a pipeline. You have to add the **Slurry** or cattle dung mixed with water through this tank. On the other side of the ball, there is another tank. It is larger than the inlet tank. This is the tank in which the **Sludge** or the fertilizer is collected. The dung, after giving out gas, flows automatically to this tank. This tank is called the **Outlet tank.** Both the inlet and outlet tanks are rectangular in shape.

Right on top of the spherical ball, a pipe is fitted. This pipe comes down to your kitchen. This is for piping the biogas, and is connected to the biogas stove in the kitchen. It is also connected to biogas lamps.

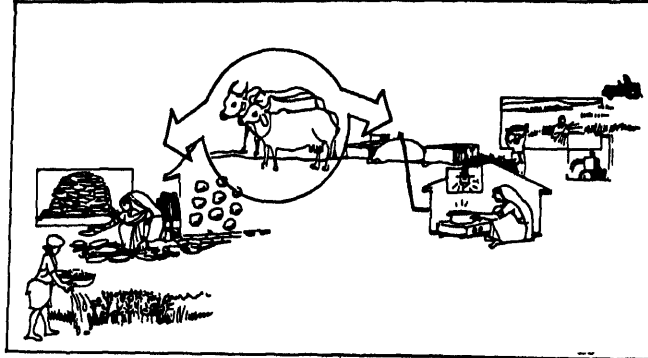
Before the pipe reaches your kitchen, it is fitted with a small tap which is at a lower level than the ground. This is used for collecting small drops of water that drip out from the gas. This is known as the **Water trap tank.**

Close to the outlet tank you have to dig a pit. This pit is to collect the sludge (fertilizer) that flows out from the outlet tank. From the pit you can take this fertilizer to your fields as and when you need it.

WHAT ARE THE BENEFITS OF BIOGAS?

The biggest advantage of a biogas plant is that it can economize on the cattle dung that is available with you. Let us take this example. You are having 2 cows, 1 buffalo and 2 oxen. At present you are not using the dung from these cattle for biogas production. Your wife needs part of this dung for making dung cakes; the rest of it is required for your field before ploughing.

On the other hand, if you put the dung in a biogas plant, it gives you both gas and fertilizer - throughout the year. No more shortages of cooking fuel during the ploughing time. No more do you have to take the trouble of running to the neighbours to buy dung for your fields.

Now we will see how biogas technology not only provides us **fuel, fertilizer,** and **hygienic**

living but also saves on our money and time. Thus, it helps us in leading a happy and prosperous life.

No Investment Needed

Moreover, you do not have to invest much money on building a plant. Once you decide to go for a biogas plant, your local bank gives you a loan. You will get the entire amount needed for the construction of the plant as loan. Also, you will get some amount as subsidy from the Government. This amount is credited to your loan and you have to repay only the balance amount. So, now you have a biogas plant without having to invest much money. Let us see some of the important benefits of biogas technology.

For Cooking

You can use biogas for cooking your food. Biogas is a very good and efficient cooking fuel. Cooking is so easy, the food gets cooked fast.

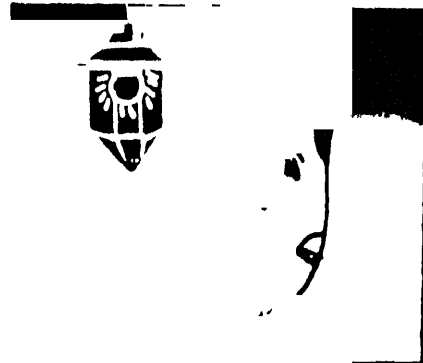
Also, you can cook any type of food with biogas - rice, *dal* , (lentil), *chapati* (bread)... anything can be cooked. And they all taste as good as ever.

Further your kitchen looks clean, neat and tidy. Your vessels do not collect soot, and shine like new ones. You need not have to take the trouble of scrubbing hard to clean the vessels.

Good Light

If you have extra biogas, you can use it for lighting your home. These lamps that use biogas burn with bright light - just like electric bulbs. Thus, it gives you good light even if your home is not electrified. Even if you have electricity, biogas lighting will reduce your electricity bills.

For Agricultural Machines

If you have several cattle heads, you can have a big biogas plant. This will give you a

large volume of biogas. You can use it for running water-pumping machines or threshers. Yes, you don't have to run to the town to fetch diesel or petrol. You can have it at your own compound. Initially, it may cost you a little more to construct a large-size plant, but it will be profitable in the long run.

Recover Fertilizer

The sludge that is left out in the plant is a good fertilizer. You can use it in your fields just as you use dung. It has all the nutrients needed for your crops. So, your crops will grow fast and healthy and give you good harvest - year after year. The sludge is much better than the inorganic fertilizer that you buy from the market. Because if you apply the inorganic fertilizers continuously for a few years, the soil slowly loses its fertility. On the other hand, if you use sludge, your soil will continue to be fertile and your money is saved from buying fertilizer from the market.

More Leisure

Apart from providing you fuel and fertilizer, biogas technology has got other benefits also. Cooking with biogas is easier and faster. Thus, your wife will have more time to help you in the field as well as to look after the children. Further, she can attend to the kitchen-garden and other household activities etc. Also, your children can spend more time on their studies.

Thus, your family members can get rid of the drudgery of daily life. You know how ?

- No botheration of constantly attending to the stove and fanning it.

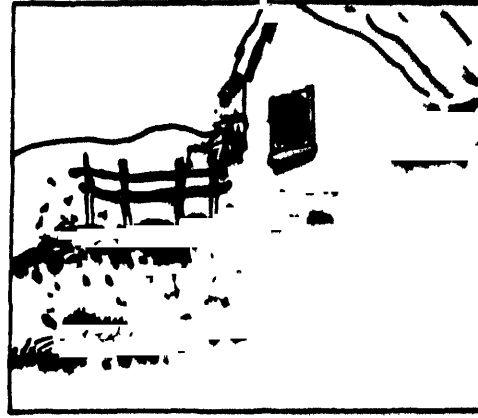
- Your family members do not have to sit and make the dung, dry and store it.

- They don't have to collect twigs and leaves for cooking.

Improved Health

Further, biogas technology brings more health to your family by way of the following advantages:

- Biogas is smokeless and thus protects your eyes from associated diseases.

Usually you store the dung near your home. This dung will attract flies which swarm on to it. This is not good for the health of your family.

It is not good to handle the dung with bare hands again and again, especially while making dung cakes for drying.

When you put the dung in a biogas plant you are avoiding this direct handling of the dung. Thus you reduce the chances of contracting the diseases associated with it. In other words, biogas technology helps in keeping the environment clean & healthy.

HOW CAN I OWN A PLANT?

For owning a biogas plant, you must have a minimum of 3-4 adult cattle heads with you - throughout the year. These could be cows, buffaloes, oxen etc. If you are rearing pigs, you must have at least 13 pigs. If you don't have any of these, but only poultry then also you can own a biogas plant. You may need to keep a minimum of 300 poultry for getting enough droppings for a small biogas plant ($2m^3$ gas/day).

Are you thinking of installing a biogas plant ? If so, please contact the extension worker or the *gram sewak* of your village. Most probably, promotion of biogas technology in your area is being handled by the *gram sewak* or a member of some voluntary organization working in your village. Meet him and tell him of your intention to build a biogas plant. For instance, tell him the number of cattle heads you

have (it is likely that you may be planning to sell or buy cattle in the coming few months. If so, it is better to do it after the calves are grown up). You must also tell him the number of members in the family, land owned by you etc. From all these the extension worker would decide about the size of the biogas plant suitable for you. He may pay a visit to your home. After this, he will give you a form: you have to fill up this with all the above details. He will thus take you to the bank to arrange for financial help for you.

With 3-4 adult cattle heads you can go in for a small $2m^3$ gas/day biogas plant. This gas is enough to cook breakfast, lunch, dinner and also to make in-between tea and snacks for a family of 4 or 5 people. Such a plant would require about Rs.5000.00 for its construction and installation. You don't have to bear the entire cost of plant construction. You will get a subsidy of Rs. 2350.00 for constructing the plant.

The subsidy is available if you hold a land of 5 acres or less. (If you own above 5 acres of land then you will get Rs. 1560.00 as subsidy). For the rest of the money, i.e. Rs.3440.00, the local extension worker will help you to get a bank loan. He will take the form to the bank and arrange for a loan.

This is how you can organize the amount (Rs.5000.00) required for constructing a biogas plant.

Once you have told the *gram sewak* of your desire to have a biogas plant, he will take you to the local branch of the bank and give you a form. You have to fill up this form and return it to the bank. This form is to enable you to get financial assistance from the bank. Meanwhile, the *gram sewak* will suggest the ideal location for your plant. The location will be somewhere near your kitchen and also not far from the cattle shed. By this you can avoid the difficulty of carrying the dung from the cattle shed to the

plant site. If possible, try to install the plant in an open space where there is a lot of sunshine throughout the year.

After about a week of filling up the form you may have to visit the bank again. By this time, the bank would have processed your form. You would be granted Rs.2000.00 as the 1st instalment. You can use this amount to get the construction materials required. Don't forget to collect and keep the cash receipts/bills for these purchases. The 2nd instalment is released on production of these receipts.

Once the plant construction work starts and the loaned money is used you will get the 2nd instalment. Thus you will get all the money needed to construct the plant in instalments. By this process you can finish the construction of the plant.

You may need about 1500 bricks, about 16 bags of cement, GI pipes (12 ft), 300 tiles, 100 ft^3 sand, 110 ft of thick nylon ropes, 2 litres of paint etc. Also, you may have to arrange for the mason. Please make sure the mason is competent in the construction of biogas plants. You must be sure about his capability. For example, has he undergone any special training for constructing biogas plants? It would be better if he has got working experience in the construction of one or two biogas plants.

You may need to employ one mason and 2 assistants for about 13 days for digging the pit and constructing the plant. The *gram sewak* will also supervise and guide the construction work.

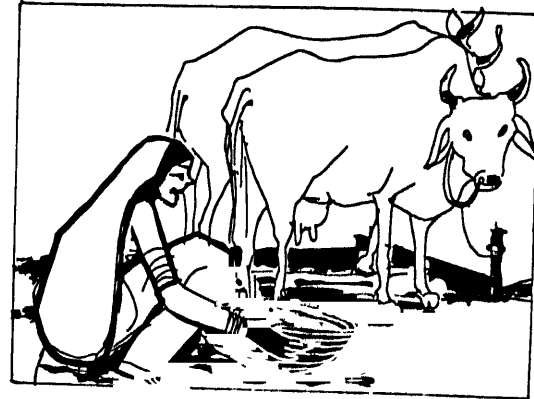
The plant would take a week's time to be completely dried up. After this, the mason will lay the gas pipe line to the kitchen. Before you start using the plant he will make a

thorough check for any possible leakage in the plant and gas pipe joints.

Once your plant is ready for use, you have to produce a certificate from the *gram sewak* saying your plant is ready for operation. You must take this certificate to the bank; the bank calculates the total amount given to you; it also calculates how much money you will get as subsidy. This amount (it may be either Rs.2350.00 if you own less than 5 acres of land or Rs.1560.00 if you own more than 5 acres) is credited to your account.

Now you owe the bank the balance amount. It may be around Rs.2650.00 (i.e. if you have got Rs. 2350.00 as subsidy) or Rs. 3,440.00 (if you have got Rs. 1560.00 as subsidy). This can be paid back at a rate of 10% interest in equal instalments within a period of 5 years.

THE INITIAL FILLING

There is another important thing that you must do during the construction period. When the plant is to be filled with slurry for the first time after construction, you would require a lot of dung. For a $2m^3$ gas/day plant you will need about 3.5 tonnes of dung. So, you must start collecting the dung from the very first day the construction begins. Make a heap of the dung on a clean surface. Care has to be taken to keep the dung away from mixing of sand or straw etc. You can cover it with sacks, bags etc. By the time the construction is over you would have most of the dung that is needed. The remaining portion you can perhaps arrange from your neighbours.

Once the construction is over and the plant is dry, then the mason would give you the green signal to fill the plant. You can put the collected dung

in the tank and pour the same quantity of water (i.e. 3500 litres). You can fill the tank with the slurry in 2 to 4 days' time. Please note that you must stop adding the slurry once it reaches close to the top step of the outlet tank.

Does your neighbour have a biogas plant? If so, collect 4-5 buckets of sludge from his plant. Otherwise, the extension worker or the mason will bring it from the next village. Now add this sludge to the mixture. If you add sludge from an existing plant, you will start getting the gas fast i.e. in about 5-6 days. Otherwise it will take a little longer.

Gas is produced........!

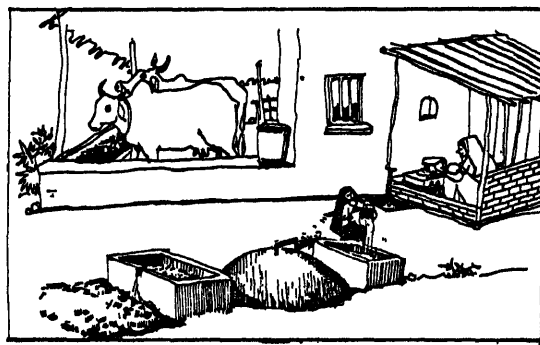
The mason would have kept the gate valve of the main pipe closed. This prevents the escaping of the produced gas. After two or three days of the filling of the tank you will notice gas bubbles in the outlet tank. This means that the plant has started producing biogas. In the beginning, only very little

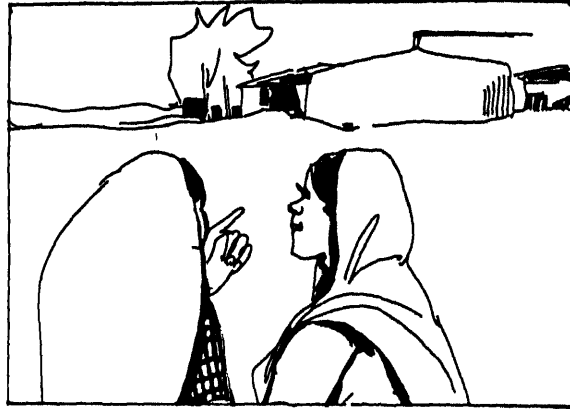
gas will be produced. But slowly more and more gas will start coming out. You can observe this from the outlet tank: in the beginning, some sludge starts coming. Later, as more gas is produced more sludge comes out to the outlet tank. Thus, the level of the sludge in this tank goes up. But even now it is not time for you to open the gas valve. Let the sludge from the tank start overflowing to the manure pit. Now you can open the gas tap and also the stove. But hold on. You may not be able to use this gas. Because, the gas that comes out at first may not be of good quality. For example, it may have a bad odour. But there is nothing to be worried about. Just let the gas off, and close the stove and the gas tap.

On the second day, check the manure pit. The sludge level would have risen in the outlet tank. If so, open the gate valve, light the match box - and open the knob of the stove. Is the gas burning with a blue flame? If yes, the biogas is

ready to be used. Otherwise, close the gate valve and burner cock. Wait for another day. On the 3rd day you would have got good quality gas that burns without any bad smell.

Now you can start your regular cooking using biogas. You can cook rice, *dal* (lentil) and vegetables, boil the milk or make *roti* or *chapati* (bread) - in short, you can do all your cooking with this. Test for yourself. Then invite your friends and neighbours. Let them know how proud you are!

From the 4th day onwards you can start feeding the plant regularly. For this, collect all the dung available on the previous day, put it in the inlet tank (remember to close the lid on the floor of the tank), add an equal quantity of water; mix it well for preparing the slurry and then open the lid. All the slurry flows into the plant. Now everyday you will get gas along with the sludge which is equally valuable as fertilizer.

TIPS FOR THE HOUSEWIFE

With biogas you can almost forget the pains of cooking. It helps you cook your food - fast, clean and without any trouble. The gas that you obtain from the dung of 4-5 cattle is enough for cooking 3 meals for a family of 4-5 members. You can make your breakfast, boil the milk, and cook your full lunch. *Chapati* (bread) will be fluffy and, more important, your *dal* (lentil) and rice would not take even half the time they used to take earlier. You can also cook your evening meal with biogas.

If your family has a lot of members - say 6-8 people, then you may have to build a bigger plant. But for a bigger plant you need more cows and buffaloes. Otherwise, you will have to use fuelwood or dungcake for cooking one meal.

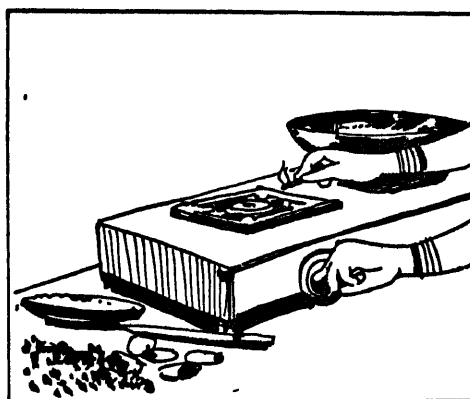
While building the biogas plant, you must insist on your

husband to buy the best biogas stove. A good stove would cost you about Rs.450.00 only.

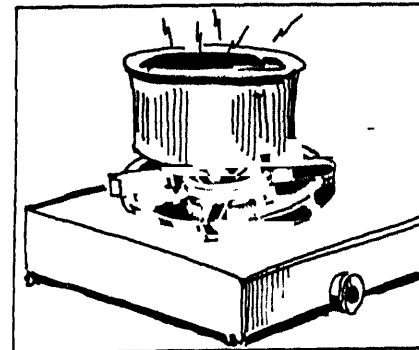
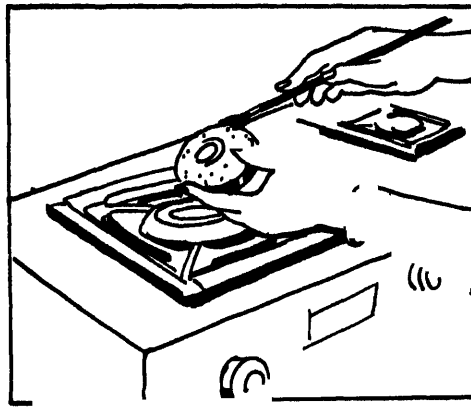
Most important of all is how well we can use the gas. Some tips are provided here for the better utilization of gas, trouble-free working of the stove and lighting burners. So, open the gas pipe (on top of the plant) in the morning only when you want to use the gas. (Also, once you have finished your cooking, don't forget to close it).

Light the match. Now open the knob of the stove. Put the lighted match on the burner. It gets the fire. Can you see blue flame ? Blue flame is important. It tells you that your vessel is getting the maximum heat without collecting soot. Now keep the cooking vessel on the stove. The tips of the flame should be touching the bottom of your vessel. It is better to use vessels with flat bottom.

You must keep in mind that all your preparations for cook-

ing are complete before you light the stove. These preparations may be cleaning and washing the rice and *dal* (lentil), cleaning and cutting of vegetables, kneading the flour etc. These are small things, but if you start these things after you have lighted the stove, you will be wasting the gas. Further, as cooking is faster with biogas you need to keep the next cooking item ready as and when one item is cooked.

While cooking *dal* (lentil), rice etc. take care that these things don't over-boil and spill over on to the stove. Your stove may be put out by it. Also, it will dirty your beautiful stove.

There is a small tip to ensure this. Keep the stove regulator in 'high' in the beginning. Once your food is cooked, reduce the flame.

After cooking each meal at the end of the day you must clean the stove with a wet cloth. For wiping, you can remove the support on which you

keep the vessel. Sometimes dust or small dirt particles may block the holes of the burner's mouth. So once a month or so, you must take it out and dust it off with a dry cloth. Thus you can ensure an uninterrupted gas supply. Your stove will work properly without any trouble.

When the cooking is done don't forget to close the gas pipe. You can do this at the end of the day also.

Similarly, for lighting the lamp, you have to open the gas tap in the house. Then light a match and put it on the mantle of the lamp. The lamp burns with a bright white light in a short while. For putting off the lamp you must close the gas tap.

Your lamp needs to be cleaned and dusted occasionally. You can dust the lamps with a piece of dry cloth. Once a week you must clean the glass covering of the lamp. For this

you must first remove it and wash it with soap and water. Let it dry in the sun. Occasionally you have to replace the mantle. For this you must remove the glass covering, take out the old mantle and fix the new one. After this you can keep the glass covering back. Mantles used in biogas lamps are the same as used for petromaxes. These are also easily available in the market.

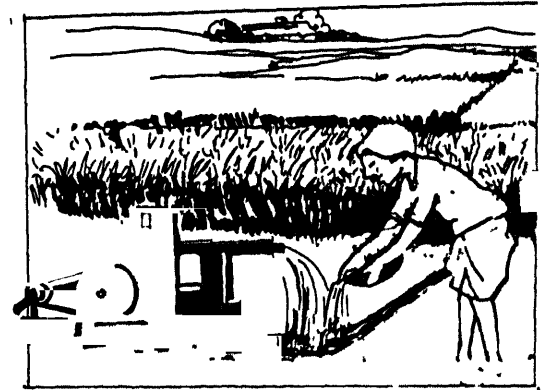
YOU HAVE THE FERTILIZER AS WELL!

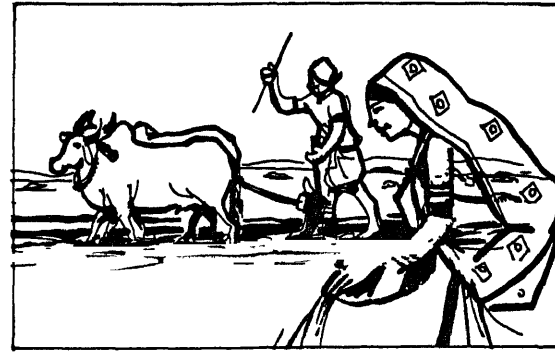
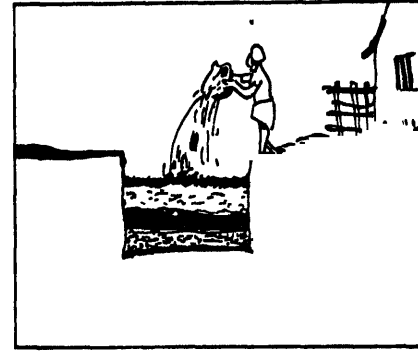
You have used the dung for producing biogas, but you have not lost the dung for fertilizer. You may ask how? You will see a liquid coming out of the biogas plant. This liquid is a very good fertilizer. It is as good a fertilizer as the dung for your crops. The dung has remained in the plant for several days. So the sludge may be lighter than dung. But it still retains all its qualities of fertilizer. For example, it has almost the same quantity of phosphate, potash and nitrate.

Which are the crops for which you use dung now? Do you use dung for paddy, sugarcane, wheat, *bajra* , guava, mango, potatoes, tomatoes, radishes, carrots ? For all these crops you can now use the sludge. You will get the same rich harvest as before.

Every day, some sludge comes out of the plant. This is collected in the outlet chamber. It is better if you dig a large pit near this chamber. Allow the sludge to flow into the pit. Otherwise, if you want to use the fertilizer periodically you can dig a long and shallow pit near the main pit, where the sludge is filled. Let the sludge run into this pit. Let it dry in the sun. When it is semi-dried you can dig it out to apply it on your field. By the time you take it to the field, it would have been dried well. Then it could be spread over the field and you could plough in.

You may need fertilizer occasionally for your vegetable garden. Take out the sludge from the pit. You can do this with a bucket. Apply it in the garden. Your vegetables will grow fast and healthy.

Do you want to apply some fertilizer to a standing crop? Then you can mix the sludge with irrigation water, and take it to the crop along with the water.

You can also use the sludge to make compost. This is possible when you are getting a lot of sludge at the same time: for example, when you are cleaning the plant. For composting you have to first dig 2-3 large pits (large enough to hold all composting materials). Now you must fill the pit with a couple of layers of straw, animal waste, leaves etc. Top all this with a layer of sludge, again a layer of straw, leaves etc., followed by another a layer of sludge. You must go on doing this until the pit is full. Now you can cover the pit. Let it remain like this for about a month. After that you can open the pit and take out the contents, apply it to the field, and plough in quickly.

Thus, biogas technology will bring in self-sufficiency in fertilizer. Besides providing you with good natural fertilizer it will save expenses on fertilizer.

TAKE CARE TO DO THE FOLLOWING!

For your biogas plant to give you gas and fertilizer - daily without any problem - you must keep the following points in mind.

Collect enough quantity of dung daily, mix it with an equal quantity of water and feed it into the plant. Remember: you cannot add all the available dung in one day; add only half of the dung in the stock the next day. Every day the same quantity of dung should be used.

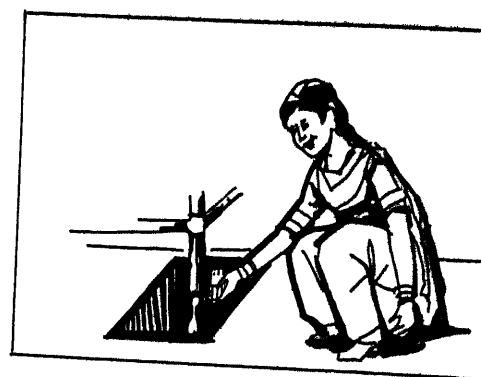
For convenience you can do the following: Measure the dung obtained in a day, using a bucket. You must use the same measure of water for mixing the dung. Before putting the dung into the inlet tank, clean the tank - there may be some leaves, grass etc. in the tank. Remove these, remove the sand also if there is any. Also, you must make sure the dung is free of any sand or grass.

Suppose you get 5 buckets of dung daily which you put in the tank: you must add 5 buckets of water to make the slurry. Use the same bucket every day to make the slurry.

Further care has to be taken for proper mixing of dung with water. This can be done by hand or with the help of a stick.

The burners should be cleaned occasionally. They will thus not only look clean and new but will also work efficiently. If you are using a biogas lamp, you should clean it periodically. Also, the mantle of the lamp has to be replaced once a month or

so, if it is damaged. Thus, they will last long and give better performance.

Have you noticed a small trap on the pipe that brings gas to your kitchen? This trap is meant for collecting the water that drips from the gas. Once a week, ask your son or daughter to open the tap of this trap and drain off the water.

The sludge that comes out of the plant is collected in the manure pit. You may not have to use it immediately in the field. Remove the sludge from the manure pit to the compost pit, if you are using it for composting. Otherwise, if you want to store it, then dig another pit for storing the dried sludge. These should be done once a month.

It is a good practice to check the plant for leakage, say, once in 6 months. You have to check the gas tap, the water

trap, and the gas pipe for leakage. You can do this by applying soapy water to the gas valve and all the joints. If there is a leak, you will notice gas bubbles. Please inform the *gram sewak* or the mason (expert on biogas plants) immediately so that they can repair the leak before too much gas is lost.

After a year or more of using the gas, you must repair the worn-out accessories. If any of these are damaged, they should also be replaced.

Your biogas plant will need some overhauling after about 5-6 years. It is better if this is done by the mason. A couple of days before starting the repair, you must stop adding dung. Now open the gate valve and remove all the gas in the plant. The mason will empty the plant by taking out all the sludge. This can be done by using a bucket through the outlet opening. Thus emptied, the plant should be left completely open for 4 or 5 days so that any gas remaining may be removed. After a week the mason can check the plant. The following points are to be kept in mind:

(i) Check thoroughly the side walls and floor for leakage.

(ii) Apply paint on the ceiling of the dome, and the gas storage chamber. Use black enamel paint for this purpose.

(iii) Check the entire gas distributing system - from the main gas taps on top of the plant down to the kitchen - thoroughly for any possible leaks.

Allow the paint to dry off in 3-4 days after the repair is over. You can reload the plant with dung and water and repeat whatever you have been doing in the beginning to obtain fuel and fertilizer.